

REMARKS

By this amendment, claim 13 has been amended. Support for the changes to independent claim 13 can be found, *inter alia*, in Figs. 1A and 1B and at page 9, line 31 – page 10, line 4 of the present specification. Claims 13, 16, 17, 19, 21-23, 25 and 26 are presented for further examination.

The rejection of claims 13, 16, 19, 23, 25, and 26 under 35 U.S.C. § 103(a) over U.S. Patent No. 6,469,448 (“Taguchi”) in view of U.S. Patent No. 6,280,563 (“Baldwin”), JP 2000-355771 (“Okabe”), and U.S. Patent Application Publication No. 2003/0168172 (“Glukhoy”) is respectfully traversed with respect to the amended claims.

The invention relates to a plasma processing apparatus for treating an object with plasma. The apparatus is configured to supply radio-frequency power into a process chamber to generate the plasma.

As recited in independent claim 13, the apparatus comprises a top plate which is disposed opposite to the object to be processed through the medium of a region for generating the plasma and the top plate comprises a metal-based or silicon-based material. The apparatus further comprises a plurality of metal-based inductively coupled radio-frequency antennas disposed in the process chamber to provide linear lines.

Electric current flows in each of the antennas in one direction so that the directions of the respective electric currents in plural antennas are the same.

Induction electric fields due to the electric currents in the plural antennas are strengthened by each other on a basis of interactions therebetween and the

adjacent antennas are in parallel with each other on the same plane which is parallel to the object to be processed.

The process chamber has a first chamber wall having a plurality of antennas so that the antennas penetrate the first chamber wall into the inside of the process chamber.

The radio-frequency antennas disposed in the process chamber are covered with an insulating material so that the radio-frequency antennas do not directly contact the plasma.

The radio-frequency power is distributed by a distributor so that the radio-frequency power can be supplied into the process chamber from the plurality of antennas.

Thus, with the structure recited in independent claim 13, provided is a plasma processing apparatus using Inductively Coupled Plasma (ICP) that can efficiently generate a high-density plasma, and particularly a high-density plasma for plasma treatment of large area substrates (see, e.g., page 18, lines 4-8 of the specification). The ICP method is based on Fleming's left-hand rule. When current flows through an electrode (antenna), a magnetic field is formed around the current and an electric field is formed perpendicular to the magnetic field. Namely, the direction of the current is very important.

By requiring that adjacent antennas are in parallel with each other, on the same plane, and parallel to the object to be processed, the direction of the electric current flowing in adjacent antennas is the same (see Figure 1A). As shown in Figure 1B, with such an arrangement of the current through the antennas, the induction electric fields in the respective plural antennas are strengthened by mutual interaction (see, e.g., page 9, line 31-page 10, line 4).

Moreover, in the present invention, the radio-frequency power is distributed by a distributor so that the radio-frequency power can be supplied into the process chamber from the plurality of antennas. (See Fig. 1A). Therefore, the electric current flows in each of the antennas in one direction so that the directions of the respective electric currents in plural antennas are the same.

Taguchi discloses a general type of ICP source, wherein a plurality of one-turn antenna coils are disposed along the circumferential side wall of the plasma generating chamber. It is an object of Taguchi to improve nonuniformity in substrate processing using an inductively coupled RF plasma source ***comprising a plurality of one-turn antenna coils*** by canceling out the radial electric fields generated between the plasma and the antenna coil.

Baldwin also discloses a general type of an ICP source. The ICP coils of Baldwin are on the top plate of a chamber so that the coils are directed from the center to the periphery of the top plate. It is an object of Baldwin to stabilize an r.f. ***coil***-excited plasma in a vacuum chamber. The Office Action cites Baldwin as disclosing a top plate with a potential applied which is made of a metal.

Okabe discloses a film deposition system comprising electrodes 4, 5 projecting from deposition film forming furnace walls 8, 9 parallel to the moving direction of a beltlike member into the discharge space of one or more deposition film forming furnaces. (See Abstract and Figure 1). In the system of Okabe, film is deposited onto a long base (strip member), used as a substrate, by continuously moving the base through two or more glow discharge regions. (See, for example, Figure 4).

In the system of Okabe, plasma is formed in a discharge space between the electrodes by applying a high voltage between the electrodes. In such a system, it is important to apply a high voltage between two electrodes to form a glow discharge, but it is not important whether the current flow through adjacent electrodes is in the same direction or in opposite directions. Thus, Okabe does not disclose the direction of current flow through the electrodes.

In the system of Okabe, electric power is reduced as the distance from a wall increases (see, for example, left-hand side of Figure 7), resulting in unevenness of a deposited film (see, for example, right-hand side of Figure 7). If the electrodes are provided projecting from the same wall and having electric current flowing in the same direction, the electric power supplied by the electrodes is reduced as the distance from the wall increases, resulting in greater unevenness of a deposited film. Therefore, in the system of Okabe, the electrodes are provided projecting from opposite walls, as shown in Figure 1.

The Office Action cites Glukhoy as disclosing an antenna disposed in the process chamber covered with an insulating material so that the radio-frequency antenna does not directly contact the plasma.

Applicants respectfully submit that one of ordinary skill in the art neither could, nor would, have substituted the coils of Taguchi modified by Baldwin for the electrodes of Okabe. In particular, as noted above, Taguchi *requires* a plurality of one-turn antenna coils, as it is an object of Taguchi to improve nonuniformity in substrate processing using an inductively coupled RF plasma source comprising a plurality of one-turn antenna coils. Additionally, the system of Okabe significantly differs from Taguchi as Okabe discloses *moving* a substrate through two or more glow discharge regions using a beltlike member.

Accordingly, Applicants further respectfully submit that the results of the proposed substitution of the coils of Taguchi modified by Baldwin for the electrodes of Okabe would not have been predictable to one of ordinary skill in the art.

Applicants additionally respectfully submit that even if one of ordinary skill in the art could have accomplished the proposed combination of Taguchi, Baldwin, Okabe, and Glukhoy, the proposed combination does not disclose or suggest all of the present claim limitations. For example, as noted above, in the system of Okabe, the glow discharge electrodes are provided projecting from opposite walls, and Okabe does not disclose the direction of current flow through the electrodes. In contrast, independent claim 13 recites, *inter alia*, that electric current flows in each of the metal-based ***inductively coupled radio-frequency antennas*** in ***one*** direction so that the directions of the respective electric currents in plural antennas are the ***same*** and induction electric fields due to the electric currents in the plural antennas are strengthened by each other on a basis of interactions therebetween.

Reconsideration and withdrawal of the rejection of claims 13, 16, 19, 23, 25, and 26 over Taguchi in view of Baldwin, Okabe, and Glukhoy are respectfully requested.

The rejection of claim 17 under 35 U.S.C. § 103(a) over Taguchi in view of Baldwin, Okabe, and Glukhoy, and further in view of U.S. Patent No. 5,975,013 ("Holland") or U.S. Patent Application Publication No. 2004/0020432 ("Takagi") and the rejection of claims 21 and 22 under 35 U.S.C. § 103(a) over Taguchi in view of Baldwin, Okabe, and Glukhoy, and further in view of U.S. Patent No. 6,390,019 ("Grimbergen") are respectfully traversed.

The secondary references of Holland, Takagi, and Grimbergen fail to remedy the deficiencies of Taguchi, Baldwin, Okabe, and Glukhoy, as noted above. The Office Action cites Holland and Takagi merely for disclosure of varying the thickness or diameter of a radio frequency antenna and Grimbergen merely for disclosure of a measuring device which is disposed in the top of the chamber so as to monitor the state of the generated plasma and a top plate which has a plurality of apertures for passing a gas to be supplied to the process chamber.

Applicants respectfully submit that one of ordinary skill in the art neither could, nor would, have accomplished the proposed combinations and that the results of the proposed combinations would not have been predictable to one of ordinary skill in the art, for at least the reasons noted above. Applicants further respectfully submit that even if one of ordinary skill in the art could have accomplished the proposed combinations, none of the proposed combinations discloses or suggests all of the present claim limitations. In particular, none of the proposed combinations discloses or suggests, *inter alia*, electric current flows in metal-based inductively coupled radio-frequency antennas in one direction so that the directions of respective electric currents in plural antennas are the same and induction electric fields due to the electric currents in the plural antennas are strengthened by each other on a basis of interactions therebetween.

Accordingly, claims 17, 19, 21 and 22, which depend either directly or indirectly from claim 13, are patentable at least for the reasons that claim 13 is patentable. Reconsideration and withdrawal of The rejection of claim 17 over Taguchi in view of Baldwin, Okabe, and Glukhoy, and further in view of Holland or Takagi and the rejection of claims 21 and 22 over Taguchi in view of Baldwin,

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Okabe, and Glukhoy, and further in view of Grimbergen are respectfully requested.

In view of the foregoing, the application is respectfully submitted to be in condition for allowance, and prompt favorable action thereon is earnestly solicited.

If there are any questions regarding this response or the application in general, a telephone call to the undersigned would be appreciated since this should expedite the prosecution of the application for all concerned.

If necessary to effect a timely response, this paper should be considered as a petition for an Extension of Time sufficient to effect a timely response, and please charge any deficiency in fees or credit any overpayments to Deposit Account No. 05-1323 (Docket # 101249.52602US).

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